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Abstract

Fe Al 40, A NEW CANNING MATERIAL FOR REACTORS USING REFRACTORY FUELS

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Fe Al 40, owing to its high aluminium content, is more suitable than stainless stells for nuclear applications ; it has two advantages : its nuclear cross section is half that of 18-10 stainless steels, and its compatibility with fuel elements and heat extracting fluids is exceptionnally good.

Ferrous alloys with more than 16 per cent by weight of aluminium are reputed to be brittle because of their ordered lattice. But actually, most of the brittleness of these alloys is due to the presence of intergranular precipitates.

The vacuum casting of pure iron and aluminium, together with additions of scavenging elements, gives a very clean alloy with sufficiently reduced brittleness at high temperatures as to allow transformation with a very good yield.

Studies of smelting and transformation have enabled the optimum composition and the best industrial fabrication conditions to be established.

The mechanical properties of extruded or rolled products are dependent on the ferritic ordered structure of the alloys prepared as follows :

Extension at room temperature between 8 and 11 p. 100

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Continuous increase of the elongation at rupture with increase of temperature so that at 800°C it exceeds 100 p. 100,

Yield strength stable at 30 kg/mm^2 from 20 to 550°C

Progressive decrease of impact strength as the temperature increases

Creep strength at 650-700°C in the region of 10 kg/mm^2 with a very high elongation because of the appearance of a fine grain recrystallization during the test.

Welding of Fe Al 40 is facilitated by the fact that this alloy remains ferritic up to its melting point (1350°C) ; however it is sensitive to hot short cracking and grain swalling. Several welding processes have been successfully applied to this alloy, under conditions where the superficial alumina layer was removed.

This very impervious oxide skin gives Fe Al 40 a unique resistance to corrosion :

- in carbon dioxide at 700°C, 60 atm, the weight gain after 3000 h is about one third of that of a 18-10 niobium - stabilized stainless steel
- in water, either de oxygenated or saturated with oxygen at 25°C, the weight gain is one hundred time smaller than that of mild steel, after a 3 month test
- in water vapour at 500°C, also after 3 monts, only the growth of impervious and very adherent oxide skins is observed
- in sodium up to 1000 h at 700°C, the behaviour is at least as good as that of stainless steel.

No diffusion reaction has been detected either with uranium dioxide up to 800°C, or with uranium carbide up to 700°C.

Extension specimens and thin walled cans are subjected to high flux irradiations between 20 and 700°C ; preliminary results will be given.